Southwest Power Pool

PRICE FORMATION TASK FORCE

March 7, 2016

Conference Call

• D o c u m e n t a t i o n o f D i s c u s s i o n •

Matt Moore (GSEC), Carrie Dixon (Xcel), Cliff Franklin (Westar), Jim Flucke (KCPL), Valerie Weigel (BEPC), and Richard Ross (AEP), with Debbie James (SPP) and Jared Greenwalt (SPP), reviewed Cliff's draft definition of "market efficiency" and metrics in order to compile comments from the PFTF members. Valerie Weigel recommended that a reliability metric be added, and the group agreed to make congestion rights a separate metric. Cliff and Carrie agreed to make the changes to the metrics and send out a revised draft to the task force members. This revised draft will be included in the background materials for the March 10th meeting *(Attachment 1 - Definition of Market Price Efficiency.docx)*.

Documented by: Debbie James, Secretary

Attachments
Attachment 1 - Definition of Market Price Efficiency.docx

ROUGH DRAFT

Whitepaper: SPP Market Efficiency Definition

SPP Price Formulation Task Force (PFTF)

February 26, 2016

This whitepaper is arranged in the following manner;

Table of Contents

I. The recommendation for a definition of SPP market efficiency

Definition of Efficient Competitive Market Design

First, meeting NERC operating standards is an absolute requirement. However, operational transparency and controls may be required to avoid over-commitment of capacity that is not required to meet reliability standards. Market prices should reasonably reflect the actual full marginal unit costs to operate the network reliably without un-necessary headroom cushion.

Second, it is important market design to have market monitoring and mitigation plans to ensure market prices are reasonably efficient avoiding significant time frames of market power manipulation. It is critical the marginal prices are not skewed by factors such as; exercise of market power manipulation, market over-mitigation that reduces buyer/investor transparency of true marginal cost of production.

Third, market products should be designed to be a reasonable balance between short-run market competition and long-run competitive equilibrium. Under perfect competitive (e.g. balanced capacity/load) conditions the market prices reflect full marginal system costs (maximizing consumer benefit) and establishes zero marginal supplier profit (maximization of supplier profit), resulting in supplier and buyer acting as price takers. All barriers to market entry and exit should be eliminated, unless absolutely necessary.

Fourth, as previously stated short-run completion needs to be balanced with long-run equilibrium capacity investment. Short-run market prices will continually move markets to long-run equilibrium by; i) allows marginal cost plus premium in capacity short markets to incent appropriate capacity expansion, ii) allows marginal cost minus a loss premium in long capacity markets incenting appropriate capacity retirements or investment delays, or iii) marginal price with no premium in perfectly balanced competition. All barriers to market entry and exit should be eliminated, unless absolutely necessary.

Thus, efficient markets are structured;

- For time frames of **capacity shortages**
  short-run marginal unit cost **+** *premium → incents appropriate capacity investment*

- for time frames of **capacity / load equilibrium**
  short-run marginal unit cost **+** *0 profit → incents appropriate capacity expansion*

- for time periods of **capacity gluts or over-supply**

  short-run completion marginal unit cost - loss premium → incents capacity retirements

II. Possible SPP metrics for measuring SPP Market efficiency

Possible Market Design Efficiency measuring metrics;

1. Day-ahead, Real-time, and Congestion rights will achieve a minimum of 95% of the long-run equilibrium cost recovery to induce right investments in productive capacity, with RUC, TCR, and RNU uplifts making up a maximum of 5%.
2. Real-time markets will be reasonably designed for suppliers to recover all market marginal costs required to startup, run, and produce an additional MW of output.
3. Scarcity pricing is reasonably designed to recover most of generators fixed costs unless the market is too long out of equilibrium.

III. Supporting topics, Background, and defintion Justification:

Sections III.A..D is designed to provide some basic wholesale electric market efficiency concepts and both regulatory, academia, and industry support for the concept of balancing short-run competion with long-run competitive equilibruim market price signals. We will start with basice concepts in Section A and then lead into various whitepapers, industry consulting reports, and texts that describe such balances. In order to be a well functioned electric market, a market must not only be competitive at times but must also send the correct price signals to LSEs and generation developers when the market is under suppliied or over supplied of various generation types.

A. Reference Author Introductions

William W. Hogan

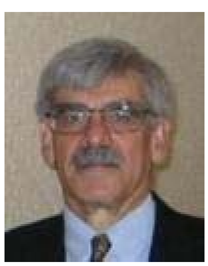
William W. Hogan is the Raymond Plank Professor of Global Energy Policy, John F. Kennedy School of Government, Harvard University. He has consulted many utility LSEs, independent generation developers, and have made filings to FERC on market design on behalf of clients and his employer. In the past, Hogan has also helped FERC develop LMP and ancillary product market development concepts for NYISO, PJM, and NEISO and is recognized as an expert in whole electricity market design.

Hogan is also one of the academics that coined the idea of wholesale market "missing money" problems that can't be seen nor hedged by MPs in DA and RT ISO/RTO market uplifts. He will be quoted in this whitepaper based on Hogan's "Electricity Market Design and Efficient Pricing: Applications for New England and Beyond".

Richard P. O'Neill

Richard P. O'Neill is the chief economic advisor at the Federal Energy Regulatory Commission (FERC) and a Fellow of the Institute for Operations Research and the Management Sciences (INFORMS). O'Neill received all three of his degrees from the University of Maryland, studying operations research with minors in mathematics, statistics, economics, and accounting. From 1969 to 1973, he taught OR and statistics at his alma mater prior to joining the computer science and business faculties at Louisiana States University.

O'Neill left academia after three years at LSU, starting a long career with federal organization. With the Energy Information Administration in the 1970s and 1980s, he directed oil and gas analysis and oversaw the development of software systems, energy modeling systems, the analysis of natural gas markets, and forecasting methods. After a two year stint as director of FERC's Office of Pipeline and Producer regulation in the late 1980s, O'Neill accepted directorship of the Office of Economic Policy. From 1988 to 2000, he also served as that office's chief economist.



O'Neill has published numerous articles on the application of operations research to energy policy, power systems, and market pricing. In 1979, he coauthored a mathematical programming model for the allocation of natural gasses. His recent work from the past decade and a half has focused on optimal transmission switching and the use of stochastic programming in power integration.

We will be quoting O'Neill from his paper on "REGULATORY EVOLUTION, MARKET DESIGN AND UNIT COMMITMENT".

Steven Stoft:

Steven Stoft is an Independent consultant in the areas of electricity market design, carbon policy and energy security. Expert witness (2004-2006) for the New England electricity market (ISO-NE) while assisting with the design of their generating-capacity market. Expert economic witness for California (2003) in in its multi-billion dollar long-term contracts case before the Federal Energy Regulatory Commission. Consulted for the Market Monitoring Unit a PJM from 1999 until 2008. In 2002, published Power System Economics, which has been translated into Russian and Chinese. From 1987 to 1997 he was a staff scientist at the Lawrence Berkeley National Laboratory and a research associate at the U.C. Energy Institute. He holds a Ph.D. in Economics from the University of California at Berkeley.

We will be quoting Stoft's IEEE book "POWER SYSTEM ECONOMICS, Designing Markets for Electricity".

The Brattle Group, Washington, DC

The Brattle Group originated in 1990 with five principals dedicated to integrity and excellence in economic and financial consulting. In 1995, Brattle combined with Incentives Research, Incorporated to strengthen its expertise in energy matters and opened its first office in Cambridge.

Since then, the firm has expanded throughout the United States and Europe to more than 300 people. We opened in Washington, DC in 1996 with a focus on regulation, antitrust, and public policy. In 1997, we entered Europe with an office in London. In 2002, we opened our San Francisco office with Nobel laureate Dan McFadden to be closer to our litigation and utility clients on the west coast and in the Pacific Rim.

Expanded into Madrid and Rome starting in 2009, and claim to be are now recognized as a top consultancy on energy, finance, and competition throughout the European Union.

2013 opened a New York office, providing a home base in one of the most important financial and legal markets. Most recently, we opened a Toronto office, allowing to respond quickly and effectively to the legal and business challenges facing our Canadian clients.

Brattle also conducts Benefit/Cost feasibility studies, SPP-Entergy merger, MISO-Entergy merger. We will be quoting the Brattle report on, "Review of PJM's Market Power Mitigation Practices in Comparison to Other Organized Electricity Markets".

Office of Energy Policy and Innovation, Federal Energy Regulatory Commission (FERC):

Staff Analysis of Shortage Pricing in RTO and ISO Markets, Price Formation in Organized Wholesale Electricity Markets, Docket No. AD14-14, October 2014

This paper is part of an effort to evaluate matters affecting price formation in the energy and ancillary services markets operated by Regional Transmission Operators (RTOs) and Independent System Operators (ISOs) subject to the jurisdiction of the Federal Energy Regulatory Commission (Commission). It focuses on shortage pricing in the RTOs and ISOs and the tariff provisions governing what defines a shortage and when shortage pricing is invoked, the interaction of shortage pricing for different energy and operating reserve products, and the RTOs' and ISOs' experiences with reserve deficiencies and shortage pricing.

B. Market Monitoring and controls for Efficient Market Design

Background research clearly shows a need for controls for behavior affecting market prices or an ability to exercise market power by; suppliers of capacity, buyers representing load, market operations, and transmission owners, and over-mitigation of markets. Since power can't easily be stored, these affecting entities can skew competitive markets up or down and inappropriately skew long-term capacity investment up or down, respectively. The Brattle Group describes the dangers of market manipulation and the parameters under which Market Monitors are required intervene into market prices, ensure FPA just and reasonable rate doctrine. In their report for PJM on page 2 Brattle states,

> ….we recommend that market power be defined as *"the ability of an individual supplier or group of suppliers to profitably maintain prices above competitive levels for a significant period of time."* However, given the unique nature of power markets, we note that a *"significant period of time"* might be as short as several dispatch periods during adverse market conditions.
>
> The exercise of market power can result in "deadweight" losses of social welfare as well as large wealth transfers from buyers to sellers (and occasionally the reverse). This is an especially important consideration in electricity markets because electricity is a necessity purchased by virtually every household and business, and is vital to our nation's health, safety, and economic viability. In addition, since electric power prices are intended to guide the efficient dispatch of generation resources involving multiple technologies and fuel types, as well as investment in transmission facilities,

a distortion in power prices can alter production and investment decisions in a manner that creates substantial additional inefficiencies.

However, the mere possession of market power is not uncommon or illegal in itself. In fact, it is common in many markets, including electricity markets, for sellers to have a modest amount of market power (i.e., some ability to raise price). Policymakers, recognizing this fact, have created the notion of "workable" competition as a more realistic goal than that provided by the theoretical concept of "perfect competition." Under workable competition, price may exceed marginal cost to some extent and firms may engage in limited exercises of market power.

Based on this concept of workable competition, the abuse of market power means exercising market power beyond a level determined by public authorities to be the limit of reasonable pricing and proper market operations. In other words, market power is abused in electricity markets when it is exercised beyond allowable levels or benchmarks, thereby leading to prices that are not considered just and reasonable under the Federal Power Act (FPA, which is administered by FERC). Since the FPA is a regulatory statute and not an antitrust law, its primary regulatory goal is the attainment of just and reasonable prices, not the preservation of competition itself, which is the essential goal of antitrust laws. Regulatory policy toward market power abuse in electricity markets is oriented toward avoiding excessive pricing—an issue that is not generally addressed by the U.S. antitrust laws.

Most reports on efficient market design hit on similar themes. However, Hogan touches on the difficulties for Market Monitoring in distinguishing "bad" high market price (e.g. caused exercise of market power) from legitimate "good" high market price (e.g. capacity/energy scarcity)_. He claims that Market caps, market rules, market operation, and Market Monitors need to be careful not to mute true marginal cost price signals for appropriate capacity investment. He states in his whitepaper, "Electricity Market Design and Efficient Pricing: Applications for New England and Beyond" on page 10,

Market Power Mitigation
The many features of an ORDC include an important and sometimes neglected connection with market power mitigation. One of the principal challenges in monitoring electricity markets has been to distinguish between (good) high prices caused by scarcity and (bad) high prices caused by the exercise of market power.

One of the principal tools for mitigating real-time market power is to combine offer requirements with offer caps. The cap sets a limit on generator offers to be close to the variable operating cost. A persistent

> difficulty is that the offer caps, while effective in mitigating market power, also have the unfortunate effect of preventing scarcity pricing from entering the market in the form of higher generator offers. Given the pricing rules without adequate accounting for scarcity, competitive generation offers could be above estimated variable costs. However, despite the defects in the pricing rules, there is a presumption that any generation offers above a reasonable estimate of variable cost must be an attempt to withhold supply and exercise market power. There is no easy means to separate the good from the bad high price outcomes.

Thus, in efficient market design, markets are not forced to competitive levels when not appropriate during scarcity conditions. In fact, Brattle discusses over-mitting markets can do harm to both long-term efficiency and the long-term equilibrium goals driven by transparent cost price signaling for future investment decisions. Brattle states that many RTOs/ISOs have correctly implemented conduct and impact thresholds from which to compare unit type reference prices. However, Brattle explains that many RTO/ISOs have carefully formulated their reference prices to make sure the market is not over-mitigated which would depress crucial transparent cost price signals required for future supplier capacity investments,

> Page 4
> While it is well recognized that consumer harm resulting from false negatives and inadvertently unmitigated market power abuse can be extensive, the long-term cost of false positives and associated over-mitigation must not be underestimated. Mitigation actions, if they are erroneous or unnecessary, can promote both short-term and long-term inefficiency. This can lead to costly changes in the operations of generating plants and distorted prices that adversely affect investment incentives, contracting behavior, demand response, innovation, and dynamic (i.e., long-run) efficiency. Even if over-mitigation does not have significant price impacts, it may create a perception of having such price impacts, which may in turn create a perception of regulatory risk and undermine supplier and investor confidence—which can also result in higher long-term costs to consumers.
> …..
> Page 6
> The conduct-and-impact approach to analyzing market power is to directly assess supplier conduct and its impact on market prices, such as bidding above cost or engaging in physical and economic withholding of output. Such conduct-and-impact tests are currently used in the ex ante mitigation processes of several RTOs including Midwest ISO (MISO), New York ISO (NYISO), ISO New England (ISO-NE), and until the Market Redesign and Technology Update (MRTU) initiative is implemented, CAISO. The currently used conduct-and-impact tests trigger mitigation if bids and their market impacts exceed certain pricing thresholds. They are applied after bids are submitted, but bids are then mitigated to appropriate reference levels (based on the test outcome) before the “official” market-clearing

price is determined. In theory, an exercise of market power under this testing approach can be observed directly by comparing bids and associated prices with competitive reference levels (e.g., marginal cost). This approach, however, requires that competitive reference levels be observable with sufficient accuracy.

Even more of a challenge, this approach requires that the regulator specify the price-cost markup threshold that is unacceptable. It is difficult to establish such a threshold in any general or abstract way, especially in the absence of substantive analysis or data pertaining to underlying cost and demand conditions and the likely nature of seller interaction absent regulatory intervention. Many healthy markets will show prices that can be substantially in excess of short-run costs (e.g., prices that are more consistent with the recovery of long-run costs), even though this outcome is not necessarily consistent with the textbook notion of perfect competition.

….

Page 60

One of the distinctive features of the Australian regulatory model is that the Australian Competition and Consumer Commission (ACCC) is both the national electricity regulator and the competition authority.

….

Page 62

The ACCC seems to accept the notion that some degree of market power needs to be exercised by generators because, unless they can push their wholesale market revenues above short-run marginal costs, they may not be able to recover their fixed costs. If this is the case, long-run competition may suffer as generators exit the market, or an insufficient amount of new generation capacity comes onto the market. The ACCC has been explicit that short-run marginal cost (SRMC) does not constitute a reasonable benchmark for competitive prices in Australia:

> The competitive level in the electricity market is not necessarily SRMC, as prices that only cover marginal costs could lead to under investment because of limited return to cover fixed costs especially where economies of scale exist. SRMC pricing is unlikely to be sustainable or desirable in this context.

C. Basic Goals of Well Functioned Market Efficiency

The following background material in Section D – F supports a simple economic concept widely supported by texts and whitepapers regarding wholesale electric market efficiency. Perfect competition exists where short-run markets provide a price signal indicating a market environment in which consumer surplus is perfectly balanced with the marginal suppliers earning zero profit. In other words, the market suppliers are perfectly matched with the demand and needs of the purchasing consumer of wholesale electricity.

This perfect balance between consumer surplus and supplier zero profit is the exception rather than the norm. Markets are not typically perfectly balanced between resource capacity characteristics and the need and demand characteristics of wholesale load.

In short markets in which such balances are not present and there exists a deficiency of certain types of capacity, well functioned markets will provide a price signal that provide market suppliers a net positive profit. Such premiums, if large enough, will incent new generation expansion that can glean profits for market products containing positive profit incentives. Over time new resource type developments will bring wholesale markets back to long-term competitive equilibrium, absent of the resource type shortages.

In long markets, flush with capacity resource types, the market price signals will provide a negative premium for marginal unit profits. If resources can't earn a profit over the long-term, such resources can either be retired or expansion plans can be delayed. Over time retirements and delays in generation expansion will bring wholesale markets back to long-term competitive equilibrium, absent of the resource type excess.

Correct price signals are important for LSEs, generation owners, and generation developers for the following hypothetical examples in well functioned wholesale markets.

In Short Markets, resource capacity types are in shortage, a well functioned market will send market marginal resource price profit that is positive enough to signal LSEs or generation owners to develop/build new resource types. The following provides some hypothetical examples.

i. If energy, regulation & mileage, spin, supplemental market prices <u>remain significantly above</u> marginal cost for months/years on end, an <u>encouraging price signal</u> is sent out for fast ramping engines/aero-derivatives/combustion turbine development,

ii. If energy, spin, supplemental market prices for both on/off peak prices <u>remain significantly above</u> the marginal costs for combined cycle for months/years on end, an <u>encouraging price signal</u> is sent out for development of combined cycle facilities,

i. if peaking season on-peak energy, regulation & mileage, spin, supplemental market prices <u>remain significantly above</u> marginal cost of older steam turbines, an <u>encouraging price signal</u> is sent out to owners to extend the unit life, and

ii. thus, after subsequent resource expansion returns SPP utilities/IPPs/LSEs to an equilibrium state.

In balanced markets having perfect short-run competition and long-run competitive equilibrium, well functioned markets send marginal resource zero profit price signals, incenting no resource expansion or retirements. The following provides some hypothetical examples.

iii. If energy, regulation & mileage, spin, supplemental market prices remain at marginal cost for months/years on end, an no price signal is sent out for fast ramping engines/aero-derivatives/combustion turbine development nor retirement,

iv. If energy, spin, supplemental market prices for both on/off peak prices remain at the marginal costs for combined cycle for months/years on end, an no price signal is sent out for development of combined cycle facilities or retirement of such facilities,

iii. if peaking season on-peak energy, regulation & mileage, spin, supplemental market prices remain at marginal cost of older steam turbines, an no price signal is sent out to owners to retire such facilities, and

iv. thus, the SPP utilities/IPPs/LSEs markets are at an equilibrium state.

Correct price signals are also important for LSEs, generation owners, and generation developers for the following hypothetical examples for making retirement delayed development decisions.

In long markets, flush and glutted with resource capacity types, a well functioned market will send market marginal resource price profit that is negative enough to signal LSEs or generation owners to either retire inefficient older resources, delay resource expansion dates, or both. The following provides some hypothetical examples.

i. If energy, regulation & mileage, spin, supplemental market prices remain significantly below marginal cost for months/years on end, a discouraging price signal is sent out for fast ramping engines/aero-derivatives/combustion turbine development,

ii. If energy, spin, supplemental market prices for both on/off peak prices remain significantly below the marginal costs for combined cycle for months/years on end, a discouraging price signal is sent out for development of combined cycle facilities,

v. if peaking season on-peak energy, regulation & mileage, spin, supplemental market prices remain significantly below marginal cost of older steam turbines, a discouraging price signal is sent out to owners to extend the unit life, and

vi. thus, after subsequent resource retirements returns SPP utilities/IPPs/LSEs to an equilibrium state.

D. Transparent Short-run market competitive prices will balances against Long-run competitive equilibrium.

Hogan states in his whitepaper, "Electricity Market Design and Efficient Pricing: Applications for New England and Beyond",

> Page 1
>
> An important objective of electricity market design is to provide efficient prices with the associated incentives for operation and investment. In the idealized theory, energy and related reserve scarcity prices would provide all that would be needed to support a market and capture the benefits of competition. In the less than perfect reality, there are many complications in achieving the theoretical ideal. The result is a resort to out-of-market (OOM) interventions and payments that create incentive problems and compromise many of the benefits of efficient markets. Although it is not possible to fully achieve the theoretical ideal, it is possible to achieve a good approximation through application of the basic principles of efficient prices.

William Hogan cites the real-time market "missing money" problem as discouragement for long-term investments when RTOs and ISOs focus exclusively, or singularly, on short-run competition. Hogan states that real-time security constrained cost transparency of all system marginal costs in real-time market price design is preferred. Other forms of revenue (e.g. forward capacity markets, financial hedging instruments, uplifts, ect) are not as effective to induce efficient and effective generation expansion investment. Hogan states in his whitepaper for NEPOOL, page 4,

> **Energy Pricing and Revenues**
>
> Organized markets operating under the only successful market design have not been completely successful. The markets share a number of problems. Perhaps the best known and most important is the so-called "missing money" problem when energy and ancillary service payments are not sufficient to cover the going forward cost of new generation investment. For a variety of reasons, pricing rules and operating practices of different types combine on average to suppress energy prices to the point that the energy prices are well below the level needed to support new generation investment. (Joskow, 2008).
>
> The goal "of the real-time market … to efficiently procure the resources required to meet the reliability needs of the system," is important. Although it may not be possible to eliminate capacity payments, OOM costs and uplift, a companion goal should be to reduce the importance of these interventions and improve the performance of the basic energy market. (Harvey, 2014) And the first-best way to address the deficiencies of the energy market is by addressing real-time pricing. Only after exhausting the consistent improvements in real-time pricing should we resort to the second-best OOM interventions. Achieving the first-best improvements relies on application of the principles of dispatch-based pricing.

OOM…Out of Merit Reliability commitment/dispatch

In late 2014, FERC opened a new NOPR on "Price Formation in Organized Wholesale Electricity Markets Docket No. AD14-14". Staff Analysis of a FERC October 2014 conference comes out the gate stating in the executive summary that real-time marginal costs should be transparent and reflect marginal unit costs, reflect loads willingness at a price to be curtailed, and that operator interventions should be minimized in order not to skew LMPs. FERC staff states in their Executive Summary,

> "Locational marginal prices for energy and ancillary services ideally would reflect the true marginal cost of production, taking into account all physical system constraints, and fully compensate all resources for the <u>variable cost of providing service</u>. If demand were fully price responsive and <u>shortage pricing rules accurately reflected the value of avoiding involuntary load curtailments, short-run energy prices would provide both an accurate price signal for short-term supply and demand behavior and facilitate long-term entry and exit.</u> To that end, Commission-jurisdictional RTO and ISO markets are built on a foundation that encourages resources to offer at a <u>price consistent with marginal cost</u>."

In Stoft's IEEE book "POWER SYSTEM ECONOMICS, Designing Markets for Electricity", pp 54-56, he asserts a common economic theory that efficient electric wholesale markets prices will balance both short-run (dispatch) efficiency with long-run (investment) efficiency. Many believe that market competition and efficiency only includes short-run consumer surplus and supplier profit maximization. Almost all texts and scholarly reviews of efficient market design will balance this one-sided point of view with long-run competition equilibrium which adequately incents efficient/effective generation expansion investment. Stoft deal in detail with both of these important components, "Short-Run Competition" and "Long-Run Competition".

Component 1: short-run market price Equilibrium competition:

There are two important components of Short-run competition;

i. Price taking traders,
ii. Well-behaved costs, and
iii. Good information (e.g. market prices reflecting marginal costs and factors affecting unit commitment and dispatch).

Price taking traders are supplier and buyers that don't control enough market share locally or regionally to control prices and act as price takers that results in both consumer surplus in which a marginal supplier earns zero profit and marginal buying load pay at a rate that covers the costs of the marginal supplier at a given point in time. This insures both cost recovery for marginal suppliers and efficient prices reflecting actual marginal cost transparency for buyers (e.g. LSEs). In such Short-run Competition, sellers offer at marginal cost recovery with zero profit for the marginal unit and buyers purchase at the true marginal cost of supply both acting as price takers. Profit is analogous to consumer surplus and is often called producer surplus.

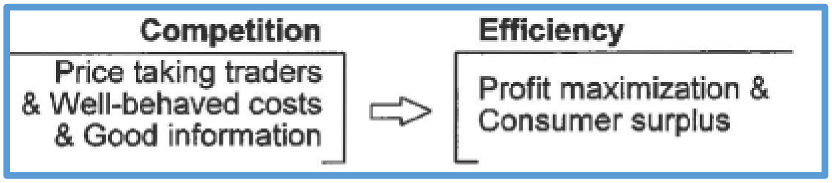
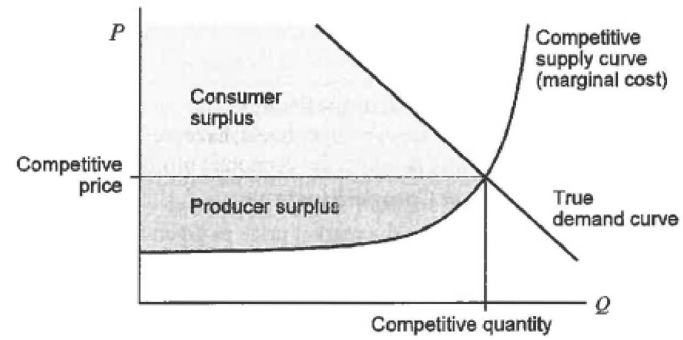


Figure 1-5.2
Total surplus equals the area between the demand curve and the marginal cost curve.



Definitions

Productive Efficiency
Production costs have been minimized given total production.

Efficiency
Total surplus has been maximized. This automatically includes minimizing the cost of what is produced and maximizing the value of what is consumed, as well as producing and consuming the right amount.

The Efficient-Competition Result

Result 1-5.1 **Competitive Prices Are Short- and Long-Run Efficient**
If productions costs are well behaved so competitive prices exist, these prices will induce short-run (dispatch) efficiency and long-run (investment) efficiency.

The Brattle Group Report for PJM emphasizes the importance of balance between short-run efficiency and long-run competition on page 45,

> "The decision regarding an appropriate reference level to which prices or bids will be mitigated necessarily balances short-term and long-term considerations. While trying to achieve prices in conformity with short-run marginal costs may be efficient in the short term, this type of mitigation can suppress price signals that would stimulate long-term investment and potentially lessen some of the need for aggressive market power mitigation in the future. ……
>
> …. In perfectly competitive markets, firms are small and act as price-takers. Since they have no ability to influence market price in this idealized setting, firms supply output up to the level where their marginal (i.e., incremental) cost of producing additional output equals market price. Thus, in a strict sense, the perfectly competitive price level is one where the market price

> equals the marginal cost of production for the firm supplying the last unit of output. And, for that reason, it is generally common to measure market power in terms of the mark-up of price over marginal cost.
>
> However, even many well-functioning markets may periodically exhibit prices that substantially exceed short-run costs (e.g., prices that are more consistent with the recovery of long-run costs). Consequently, holding electricity markets to a standard of perfect competition, where prices reflect short-run marginal production costs, may stymie attempts to transition to a state of less regulation. "

In Short-run competition equilibrium, Stoft states, Further Stoft states, if costs are not well behaved and lack recovery of startup and no-load costs, then short-run competition equilibrium and long-run competition equilibrium will not be balanced nor optimal. Further, if market traders lack adequate information, including publicly known prices or factors affecting market prices (e.g. constraint paths, DA & RT reliability commitments, congestion on paths, headroom commitments, ex-post uplifts, ramp deficiencies, exercise of scarcity pricing, etc) market traders may be discouraged from finding a true competitive equilibrium that result in an optimal set of trades.

For Long-term Equilibrium that induce investment in new generation, Stoft states,

> "Economics, and this book, define cost to include a normal rate of return on all investment. This rate of return is defined to include a risk premium. If a supplier covers its costs, it automatically earns a normal rate of return, including an appropriate risk premium, on its entire investment. Under this definition of "normal," a business that earns more is considered to be worth investing in, and a business that earns less is not. A normal business investment, therefore, has revenues that exactly cover all its costs in the economist's sense. Because profit equals revenue minus cost, a normally profitable supplier earns zero profit.
>
> …..
>
> In the short run, it is possible to design market rules which lower the market price without reducing supply. This is difficult but possible. But at a lower price producers will not cover their fixed costs. This will make future investors think twice. The result will be a risk -premium added to the cost of capital and future production will be more costly than it would have been had cost been left at the competitive level.
>
> Competition does not guarantee the lowest possible price at any point in time. Instead it guarantees that suppliers will just cover the long-run total costs and no more. It also guarantees that the cheapest suppliers will be the ones producing. Together these mean production costs (including the long-run cost of invested capital) are minimized and producers are paid only enough to cover their cost. This implies that the long-run average cost to consumers is also minimized. No market design regulated or unregulated can induce suppliers to sell below cost on average. Competition minimizes

long-run average costs of production and long-run average costs to consumers."

Component 2: Long-run market price Equilibrium competition:

Long-Run Competition is equally important linked to Short-Run Competition both internally/externally. Proper short-run price formation that avoids both;

a. significant market price deficiency resulting in marginal supplier cost losses, or
b. significant market price windfall profits for marginal suppliers.

Stoft states that Long-run equilibrium concerns;

Long-Run Competition

> "A short-run competitive equilibrium is (short-run) efficient; it makes the best use of presently available productive resources. A long-run competitive equilibrium guarantees that the right investments in productive capacity have been made but requires that the three short-run conditions be met and adds two new ones. Production costs must not possess the conditions for a natural monopoly (see Section 1-1.1), and competitors must be able to enter the market freely. With free entry, if there are above-normal profits to be made, new suppliers will enter which will reduce the level of profits. In this way free entry ensures that profits will not be above normal. A normal profit level is the key characteristic of a long-run competitive equilibrium. Barriers to entry is the term used to describe market characteristics that prevent free entry. Efficiency and Total Surplus Almost every proposed market design is declared efficient, but in economics the term has a specific meaning. The simplest meaning applies to productive efficiency which means that what is being produced is being produced at the least possible cost.
>
> Minimizing cost is often the most difficult part of the market designer's problem, so this meaning is generally sufficient. When not qualified as productive efficiency, efficiency includes both the supply and demand sides of the market. Efficiency means (1) the output is produced by the cheapest suppliers, (2) it is consumed by those most willing to pay for it, and (3) the right amount is produced. These three can be combined into a single criterion by using the concept of consumer surplus."

Thus, Hogan, FERC, Brattle, and Stoft all emphasizes the goal of correct efficient effective supply rather than the alternative objective to over mitigation and force market prices at, or in SPP's case below, marginal cost production for the next unit of power. If dispatch is effectively deployed by an RTO, efficiently dispatched, and efficiently offered by the majority of resource owners at marginal cost, then correct price signals will be provided.

E. Well Functioned Markets: market operator actions are minimized, as much as possible, with operators managing network reliability as a given.

Richard O'Neill in is paper on "REGULATORY EVOLUTION, MARKET DESIGN AND UNIT COMMITMENT", questions arbitrary relaxation of constraints in order to avoid either high energy or high scarcity prices. He states that such actions, taken to extremes, increase the probability of system failures. The papers indirectly implies that shortage pricing should be based on demand-side resource offers.

> "Page 15
>
> **Reserves Markets.** The establishment of efficient ancillary service markets is an ongoing market design challenge. As the cost of reliability increases and in the absence of a way to represent willingness to pay for ancillary services, the RTO system operator can relax reserve margins and transmission constraints. This is, in fact, written into the market rules in some ISOs; it remains a contentious issue, largely because it has involved system operator discretion that results in changes in market prices. The relaxation of these constraints increases the probability of a system failure; as such, it should be part of the operational parameters of the auction decided in advance of the day-ahead auction so that actions of the system operator are not seen as arbitrary.
>
> …..
>
> Page 9
>
> The multi-settlement system has been adopted by all the ISOs in recognition of the value of the forward market as a financial hedge for real-time conditions. Also, the forward market should facilitate demand-side responses by giving demand that has bid to reduce load more time to react to price signals."

In the FERC AD14-14 NOPR Staff summary of it's Price Formation Technical Conference, October 2014, staff strongly implies that real-time marginal energy and ancillary prices should reflect the true cost of operator actions taken to resolve any reliability issues. FERC alludes that ramp shortages and operating reserve shortages may need to be priced differently but both should somehow reflect prices of load willingness to be curtailed. FERC staff states the following in various parts of their summary,

> "Page 4
>
> When the system operator is unable to meet system needs, it applies administrative pricing rules to ensure that costs, including the costs associated with the failure to meet minimum operating reserve requirements, are reflected in market prices. Ideally, these prices would reflect the valuation consumers place on avoiding an involuntary load curtailment. Under such conditions, prices should rise, inducing performance of existing supply resources and encouraging load to reduce consumption so that the system operator would not need to administratively curtail load to maintain reliability. A failure to properly

reflect in market prices the value of reliability to consumers and operator actions taken to ensure reliability can lead to inefficient prices in the energy and ancillary services markets leading to inefficient system utilization, and muted investment signals. Reducing such inefficiencies may lead to more reliable and more economic electric service to consumers.

…..

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C. Operator Actions

One of the most important differences between the RTOs and ISOs is what actually triggers shortage pricing. If an event is triggered too late, the market may be late to respond to the system's needs. Or, if operator actions taken to avoid a shortage are not priced, prices may fail to appropriately signal tight market conditions. Every RTO and ISO has steps the system operator can and must take in order to avert a shortage. However, if a goal of shortage pricing is to reflect in prices the cost of a shortage, it also may be important to price certain operator actions taken to avert a shortage.

The actions system operators take to avert a shortage, such as importing emergency energy or instituting a voltage drop, trigger shortage pricing in some RTOs and ISOs but not others. While NYISO and PJM invoke shortage pricing in response to certain operator actions, CAISO implements shortage pricing in a market run prior to an actual shortage occurring.37 NYISO activates shortage pricing when Emergency Demand Response is dispatched. PJM considers a voltage drop to be an emergency action that triggers shortage pricing. Different still, many of MISO's shortage events are triggered by ramping constraints that limit the system operator's ability to meet reserve requirements. That is, MISO has sufficient capacity to meet its reserve requirements, but has insufficient ramp capability to meet load and thus, must dip into its reserve capacity to serve load. On the other hand, SPP specifically forbids ramping constraints from triggering shortage pricing, thus masking whether the RTO is short of operating reserves or short of ramping capability. These differences across RTOs and ISOs, combined with system and meteorological events, lead to different experiences with shortage events and shortage pricing in the RTOs and ISOs.

….

Table 12. CAISO Shortage Pricing

Reserve Product	Reserve Product
Regulation-Up	$200
Spinning Reserve	$100
Non-Spinning Reserve	
Shortage > 210 MW	$700
210 MW > Shortage > 70 MW	$600
70 MW > Shortage	$500
Maximum Upward Sum	$1000 ($200+$100+$700)
Regulation-Down	
Shortage > 84 MW	$700
84 MW> Shortage > 32 MW	$600
32 MW > Shortage	$500

Table 14. MISO Shortage Pricing

Product Shortage	Price
MISO-wide Operating Reserve	Min. $200/MWh to Max. VOLL ($3500/MWh) minus Regulating Reserve demand curve value, depending on level of shortage.
MISO-wide Spinning and Regulating Reserves	Min. $65/MWh to Max. $98/MWh depending on level of shortage.
MISO-wide Regulating Reserve	Max. of (i) Contingency Reserve Offer Cap and (ii) Peaker Commitment Cost for one hour.
MISO-wide Energy	LMP set to Value of Lost Load ($3500/MWh).
Reserve Zone Operating Reserve	Min. $200/Mwh to Max. VOLL ($3500/MWh) minus maximum Regulating Reserve Demand Curve Scarcity Price.
Reserve Zone Spinning and Regulating Reserves	$65/MWh if > 90% of requirement. $98/Mwh if < 90% of requirement.
Reserve Zone Regulating Reserve	Max. of (i) Contingency Reserve Offer Cap and (ii) Peaker Commitment Cost for one hour.

Table 16. PJM Shortage Pricing

Product Shortage	Price/Penalty Factor
Synchronous Reserve	$550/MWh
Non-Synchronous Reserve	$550/MWh
Regulation	n/a
Voltage Drop	$2100 = $1000/MWh + Synchronous and Non-Synchronous penalties ($1100)
Energy	$2100 = $1000/MWh + Synchronous and Non-Synchronous penalties ($1100)

Table 17. SPP System-Wide Shortage Pricing

Requirement	Market-Clearing Price
Supplemental Reserve	$1100 + Zonal Regulation-Up plus Contingency Reserve Shadow Price
Spinning Reserve	$200 + Supplemental Reserve MCP + Zonal Regulation-Up plus Contingency Reserve Shadow Price
Regulation-Up Reserve	$600 + Spinning Reserve MCP + Zonal Regulation-Up Shadow Price
Regulation-Down Reserve	$600
Energy	LMP accounts for all Shortage-Priced MCPs with a maximum = $50,000.

….

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In ISO-NE, operator actions related to the dispatch of demand response resources have resulted in instances of relatively low prices during tight system conditions. Under ISO-NE's currently-effective tariff, demand response is classified as a "non-dispatchable" resource and is therefore not eligible to set prices; rather, demand response resources are dispatched manually by the system operator during certain shortage or near-shortage events. However, the External Market Monitor notes that "[t]he activation of demand response in real-time can inefficiently depress real-time prices substantially below the marginal cost of the foregone consumption by the demand response resources, particularly during shortages or near-shortage conditions.

….

Table 13. ISO-NE Reserve Constraint Penalty Factors

Requirement	Price
Local Thirty-Minute Operating Reserve	$250
System Thirty-Minute Operating Reserve	$500
System Ten-Minute Non-Spinning Reserve	$850
System Ten-Minute Spinning Reserve	$50
Replacement Reserve	$250

….

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In summer 2013, NYISO implemented an Enhanced Scarcity Pricing Rule that was designed to ensure that real-time prices better reflect real-time shortages. NYISO deployed demand response on five days in 2013: July 15 through July 19. NYISO's External Market Monitor found the new shortage pricing rule was applied in the vast majority of intervals when demand response was actually needed (234 of 266 intervals),48 although the External Market Monitor also noted that shortage pricing is only applied to internal locations, resulting in large differences between real-time prices at internal and external interfaces. The External Market Monitor noted that, when market participants expect a shortage event the next day, this can lead to incentives for participants to import day-ahead and buy back at non-shortage real-time prices. This strategy, which can lead to additional export demand during likely shortage events, would not be profitable if shortage pricing were applied to external interface ties.

….

Table 6. NYISO Shortage Pricing ($/MWh)

Service	Shortfall	New York Control Area	East of Central East (New York City or Long Island)	Long Island only
Regulation	0 to 25	80	n/a	n/a
	> 25 to 80	180	n/a	n/a
	> 80	400	n/a	n/a
Thirty-Minute	0 to 200	50	25	25
	> 200 to 400	100	25	25
	> 400	200	25	25
Total Ten-Minute	> 0	450	500	25
Total Spinning	> 0	500	25	25

"

Hogan addresses his perceived failure of markets to successfully implement efficient demand-side managed load curtailment offers in the past. He then discusses Operating Reserve Demand Curves (ORDC) commonly used in RTO and ISO market today. Hogan suggest refinements for the NEISO scarcity pricing construct by developing ORDC to account for the "missing money" problem in marginal prices.

"Page 8

The importance of operating reserves has always been known, but the requirements for operating reserves were given only a simplified consideration in early wholesale electricity market design. The assumption was that the operating reserve requirement at any moment and location could be represented by a fixed requirement, and that economic dispatch would produce simultaneous optimization that would incorporate the dispatch of energy and reserves. Pricing, especially during shortage conditions, would be provided by demand bidding to voluntarily reduce load at high prices, and the value of operating reserves would be determined by the implied scarcity prices. While this was a workable approximation in theory, it failed in practice when the associated demand bidding did not materialize.

One solution to this problem is to revisit the pricing of operating reserves through a better representation of an operating reserve demand curve (ORDC). To be sure, an operating reserve demand curve is an administrative intervention in the market. But this is already true of the administrative requirement for operating reserves. In the presence of a necessary and inevitable operating reserve requirement, it is clear that the superior administrative rule would be a better model of the demand for operating reserves that goes beyond the fixed quantity requirement. (Hogan, 2005)

Several ISOs have implemented variants of an ORDC, but without the connection to the underlying scarcity principles. The RCPF approach in ISONE already provides a price for operating reserves. This is a scarcity pricing mechanism. However, the level of the payments and conditions under which the payments are made are not derived from the underlying principles of economic dispatch or an explicit model for the reliability requirement. As a result, the prices are too low in at least two ways. The RCPF is not high enough to account for real scarcity costs just when the system is most constrained and the efficient price would be most important. The highest reserve penalty factor cap is only $850/MWh. In addition, in its early implementation the RCPF was not applied during more than 95% of the hours when the value of additional reserves should be lower but not zero. (p. 67) (ISONE, 2014a) The subsequent reforms to increase the penalty payments doubled the number of hours and the value paid for operating reserves. (ISONE Internal Market Monitor, 2014) But the focus remains on a limited number shortage hours that leaves most hours with no scarcity prices. By contrast, small scarcity payments applied across many hours could make a material contribution to reducing the missing money.

A Structure of Scarcity Pricing Through Operating Reserves. The basic outline of an operating reserve demand curve with efficient prices follows from the description above. Although the ORDC would be integrated with the dispatch model, rather than applied solely in a pricing model, it is in the spirit of dispatch-based pricing in using a simplified scarcity pricing model to approximate the more complicated set of security decisions found in the real dispatch. The key connection is with the value of lost load (VOLL) and the probability that the load will be curtailed. (Potomac Economics, 2014) Whenever there is involuntary load curtailment and the system has just the minimum of contingency operating reserves, then any increment of reserves would correspondingly reduce the load curtailment. Hence the price of operating reserves should be set at the value of lost load during these periods."

Stoft's also touches on market operation intervention into competitive market prices when stating,

"Page 77

Structure vs. Architecture of the Balancing Market. The balancing market keeps supply and demand in balance until the system operator is forced to balance the system by shedding load. This market must be administered by the system operator, but it may include a sizable bilateral component. It may be integrated with the markets for operating reserves, or these may be separate. These are questions of market architecture. At a more detailed level, there are innumerable choices concerning market rules. The market rules and architecture do not determine the height and duration of real-time price spikes, nor how closely voltage and frequency will be maintained, nor the chance that the system will not recover from an unexpected generation failure. These fundamentals are determined by the structure of the balancing market. The rules and architecture determine how efficiently trades are organized, who gets their transaction terminated when reliability is threatened, and how closely prices approximate the competitive level. The structure of the balancing market is in part determined by the interconnection's reliability authority (NERC) and in part by local design. It is also influenced by the regional regulatory authority (FERC) when it caps real-time prices. The accuracy of balancing and short-term reliability are largely determined by the structure of the balancing market Less obviously, price spikes, generation investment and long-term reliability are also largely determined by the balancing market. From this perspective, current balancing market structures appear haphazard and inappropriate."

Stoft's addresses the fallacies of the marginal cost market function and need for market rents and scarcity pricing by providing an example, that scarcity marginal prices should be based upon a loads price and willingness to be curtailed/shed. Stoft states,

"Page 63

Fallacies

Two basic fallacies underlie a series of misconceptions surrounding competitive pricing and market power. These are (1) the Marginal-Cost Fallacy and (2) the Ambiguous-Price Fallacy. Both of these will be illustrated using Figure 1-6.2, which shows a normal demand curve and a supply curve that is constant at $30/MWh up to an output of 10 GW, the capacity limit of all available generation.

The Marginal-Cost Fallacy takes two forms. The simple form asserts that marginal cost at Q = 10,000 MW is $30/MWh in Figure 1-6.2. The subtle form asserts that nothing can be said about the marginal cost at this output level. Some of the conclusions drawn from these assertions are as follows:

1. The competitive price is $30/MWh, and the market should be designed to hold prices down to this level.

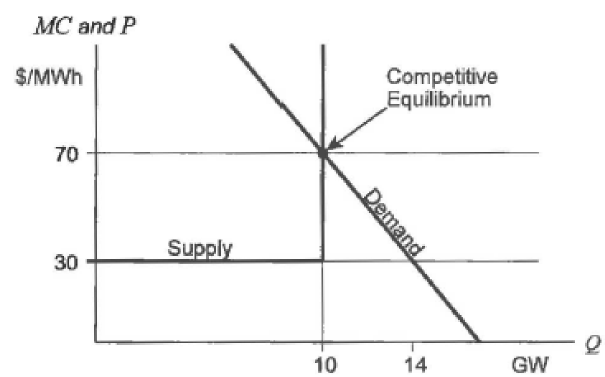
2. The competitive price is $30/MWh, and this is too low to cover fixed costs, so marginal-cost prices are inappropriate for power markets.

3. Scarcity rents are needed to raise prices above marginal-cost-based prices.

4. Market power is necessary to raise prices to an appropriate level.

5. The competitive price cannot be determined.

Figure 1-6.2
A normal market equilibrium for an abnormal supply curve.



All of these conclusions assume that there is some problem with standard economics caused by the supply curve coming to an abrupt end instead of turning up smoothly as it does in undergraduate texts. In fact, economic theory has no difficulty with this example, and all of the above conclusions are false. Consider a competitive market, with many suppliers and many customers, described by the curves in Figure 1-6.2. What if the price in this market were $30/MWh? At this price, the demand curve shows an excess demand of about 4 GW. Some customers trying to buy more power are willing to pay up to $70/MWh for another MW of supply. They will find a supplier and offer to pay considerably more than $30, and the supplier will accept. This shows that the competitive price is above $30/MWh. The story will be repeated many times, with different values, until the market price reaches $70/MWh. At that price every supplier will produce at full output, so the supply will be 10 GW, and demand will be 10 GW At any higher price demand would fall short of supply, so the price would fall, and at any lower price, demand would exceed supply, so the price would rise. There is nothing unusual about this equilibrium; it is the classic story of how price clears a market by equating supply and demand.

The Marginal-Cost Fallacy

Fallacy 1-6.1	**Marginal Cost Equals the Cost of the Last Unit Produced** Marginal cost equals the savings from producing less even when this is different from the cost of producing more. **(Subtle Version)** Nothing can be said about marginal cost at the point where a supply curve ends or jumps from one level to another.

But shouldn't price equal marginal cost? In this example, all that can be said is that marginal cost is greater than $30/MWh. So there is no contradiction between price and marginal cost, but they cannot be proven to be equal. The desire to pin down marginal cost precisely seems to arise from a belief that competitive suppliers should set price equal to marginal cost and thereby determine the market price.

But this logic is backwards. As explained in Section 1-5.3, suppliers set price to clear the market and set quantity to bring marginal cost in line with price. In this example, the market-clearing forces of supply and demand determine price unambiguously, and although marginal cost is ambiguous, it is greater than $30/MWh which is enough to determine supply unambiguously. Everything of practical importance is precisely determined.

The Ambiguous-Price Fallacy

Fallacy	1-6.2	**When Marginal Cost Is Ambiguous, so Is the Competitive Price** Competitive suppliers set price equal to marginal cost; thus when marginal cost is hard to determine, the competitive price is hard to determine.

Having analyzed the example, the preceding list of incorrect conclusions can be restated in their.

1. The competitive price is not $30/MWh, and the market design should not hold price to this level.

2. The competitive price is high enough to contribute significantly to fixed cost recovery.

3. No mysterious "scarcity rent'' need be added to the marginal cost of physical production.

4. Market power is not needed if the market is allowed to clear.

a. The competitive price is $70/MWh."

F. Well Functioned Markets: un-necessary DA and RT market barriers should be removed when possible and "Free-Entry" should be the norm.

Barriers harmful to markets becoming efficient, especially if barriers are unnecessary not required. Entry and exit barriers can include unreasonable/unjustified credit requirements, unwieldy pancaked transmission rates preventing external imports/exports, unreasonable membership fees, unreasonable membership entry/exit requirements, unreasonable stakeholder governance (eg. Including membership voting rules), unreasonable financial market requirements, etc. The Brattle Group provides a compelling and concise reasoning to eliminate all unnecessary barriers that can moot market entry that can control existing market power issues.

"Page 14-15

It should be noted that constraints exist on the loss of social welfare sustained through exercises of market power that arise in a dynamic environment, where market entry or capacity expansion can occur. If the

> exercise of market power by market participants creates excess profits in wholesale electric markets, new participants will enter the market until wholesale power prices fall to a level associated with a normal, risk-adjusted return on investment. Consequently, the ability of firms to enter the market will act as a constraint on the exercise of market power, except when the market is characterized by barriers to entry or inherent monopoly conditions. However, entry or capacity expansion in electric power markets often requires several years, so entry cannot be expected to alleviate near-term market power.

Inappropriate market barriers can consist of RTO rules that enable; pancaked transmission rates, unjustified preference for uneconomical resources, unjustified preference for larger or smaller Market Participants, unjustified preferences for either suppliers or buyers, and unjustified preferences for either newer or existing generation/transmission technologies. FERC staff in their summary of RTO strategies to recover costs talks about MISO's Extended LMP (ELMP) designed to recover energy, start-up, and no-load costs for block loaded units that can set ex-post prices.

O'Neill also mentions that market financial barriers to free entry and exit should be avoided. One barrier discussed concerns suppliers recovery of actual marginal costs in Day-Ahead markets. Mr. O'Neill states that cost development should be based on reasonable approximations of Short-Run Marginal Cost (SRMC) equating the approximation with actual (incremental or going forward) costs. Not to allow such recovery in market design constitutes a market price distortion, or sets up a market barrier impeding participation by; generators, buyers having un-transparent price discovery, and efficient generation investment based on skewed market prices. O'Neill states,

> This section addresses the prospective RTO day-ahead market, which is defined as the market in which the initial bidding to provide energy and ancillary services for reliability, congestion management, and energy balancing takes place. As is done currently in ISO markets, this market would be conducted on the day prior to the dispatch day. The dual objectives of the day-ahead market are to achieve economic efficiency and ensure system reliability.
>
> The day-ahead market is a physical market where all expected balancing/ancillary services are scheduled. The design for the day-ahead market is discussed below and it assumes that there is a real-time market, in which adjustments are made to energy and ancillary services reflecting the differences between day-ahead expectations and real-time conditions.[22]
>
> The following is a list of recommended design principles derived from the foregoing analysis and experience to date, with short explanations and clarifications.
>
> ……
>
> **Principle 3: Remove disincentives to market participation. Participation in an RTO market should involve low transaction costs and create minimal additional risks.**

Minimal participation in the market is the submission of generation and consumption quantities (that is, bids which are taken at any price, or "at market"). Any unit dispatched should be guaranteed bid-cost recovery.

Principle 4: Bidding protocols should promote flexibility of participation. All market participants should be allowed, but not required, to submit multi-part bids that reflect short-term marginal costs. Market participants should be allowed to self-schedule, that is, allowed to submit quantity only bids.

This principle requires that all resources have the option to bid a reasonable approximation of their short-term marginal cost function, including start-up, no-load, and energy costs (in addition to technical parameters, such as minimum and maximum load limits, ramp rates, and minimum shutdown time). Although a bid function will seldom serve as a perfect match for actual marginal (incremental or going forward) costs, a good approximation should be available.

…. As discussed above, there are technical, financial, and economic reasons for adopting multi-part bidding.

While the multi-part bid allows for more accurate representation of marginal costs and thus, in the absence of market power, should result in a more efficient solution, it also results in a non-convex supply function. In turn, this makes the market equilibrium and prices harder to derive. This complication can be addressed and made manageable with some simplifying assumptions about which generators are allowed to bid nonconvex costs, whether some parameters should be fixed for a specified period (such as ramp rates, maximum and minimum output), and what should be fixed in the bid function.

Demand bid functions are essentially the mirror images of generator bid functions but will not be discussed in detail here. Consumers need more explicitly defined contracts to participate properly in the market and should be allowed bid functions similar to the generators.

[22] The real-time market will not be examined in depth here. However, efficient market design requires that most principles be adhered to with respect to the relationship of the real-time and day-ahead markets. Bids should be submitted separately into the real-time market, and market prices based just on those bids. Deviations from the day-ahead market should pay the real-time price unless there is a reliability problem. If a bidder does not deviate from the day-ahead schedule, there are no additional costs to pay based on the real-time market. Finally, the market operator needs to keep the system in balance at the nodal level using bids to the extent possible.

Stoft's also reviews NYISO policies to help block-loaded unit cost recovery issues and how they have rolled in startup and no-load marginal block-loaded unit costs into ex-post LMPs. Stoft's also addresses market barriers that enhances existing resources with market power.

"Page 335

Barriers to Entry. If there is a large cost to generation entering the market, this has an effect similar to market power. It can reduce capacity and cause the market price to increase. If the barrier is created by one of the suppliers in order to raise the market price, the strategy is profitable, it might be considered an exercise of long-run market power. Long-run market power might be defined as the ability to raise the market price above the long-run competitive price.....More typically, barriers to entry are not create by market participants and would not fit under any definition of market power. One such barrier is the cost of obtaining permission to build generation.

Many RTOs arrange seam rules that are designed to reduce barriers between markets. PJM-MISO have eliminated transmission rate pancaking, have plans to create a Coordinated Transaction Scheduling (CTS) bid/offer portal for market participants desiring to arbitrage congestion across the PJM-MISO seam without risks of transmission costs or uplifts. The NYISO-PJM seam have an existing CTS portal.

In summary, a market desiring efficiency will incent both short-run completion equilibrium and long-term competition equilibrium, valuing both objectives equally. The periodicals and experience leads that the following objectives can be pursued by the PFTF to achieve market efficiency;

1. creation of transparent market costs and factors that impact market prices (e.g. RT load, RT reserves, RT commitments, RT headroom, deployment of demand scarcity pricing, ramping reserves),
2. creation of transparent marginal cost recovery that recover all marginal costs for units setting the marginal price
3. Reasonably capture all marginal/start-up/no-load costs for block – loaded/engines/QS units frequently committed reliability and ramping,
4. highly prioritize long-run fixed cost recovery, including capital and risk premiums, necessary to incent effective and efficient new investment removal of inefficient market barriers that unreasonably impedes ability of; external Market Participant participation, financial Market Participants, and advanced/new technologies participation,
5. use of demand market reserve scarcity prices/rents that reflect loads willingness to be curtailed,
6. if possible, incent demand-side management resources required to discover scarcity pricing, and finally
7. existence of short-run transparent marginal cost recovery for reserve capacity committed for headroom/ramping reserves except for periods of resource type over-supply.

IV. The recommendation for a definition of SPP market efficiency is repeated

Thus, based on the research of periodicals and texts in this whitepaper, my proposal for a definition for Market Efficiency includes the following.

Definition of Efficient Competitive Market Design

First, meeting NERC operating standards is an absolute requirement. However, operational transparency and controls may be required to avoid over-commitment of capacity that is not required to meet reliability standards. Market prices should reasonably reflect the actual full marginal unit costs to operate the network reliably without un-necessary headroom cushion.

Second, it is important market design to have market monitoring and mitigation plans to ensure market prices are reasonably efficient avoiding significant time frames of market power manipulation. It is critical the marginal prices are not skewed by factors such as; exercise of market power manipulation, market over-mitigation that reduces buyer/investor transparency of true marginal cost of production.

Third, market products should be designed to be a reasonable balance between short-run market competition and long-run competitive equilibrium. Under perfect competitive (e.g. balanced capacity/load) conditions the market prices reflect full marginal system costs (maximizing consumer benefit) and establishes zero marginal supplier profit (maximization of supplier profit), resulting in supplier and buyer acting as price takers. All barriers to market entry and exit should be eliminated, unless absolutely necessary.

Fourth, as previously stated short-run completion needs to be balanced with long-run equilibrium capacity investment. Short-run market prices will continually move markets to long-run equilibrium by; i) allows marginal cost plus premium in capacity short markets to incent appropriate capacity expansion, ii) allows marginal cost minus a loss premium in long capacity markets incenting appropriate capacity retirements or investment delays, or iii) marginal price with no premium in perfectly balanced competition. All barriers to market entry and exit should be eliminated, unless absolutely necessary.

Thus, efficient markets are structured;

- For time frames of **capacity shortages**
  short-run marginal unit cost **+** *premium → incents appropriate capacity investment*

- for time frames of **capacity / load equilibrium**
  short-run marginal unit cost **+** *0 profit → incents appropriate capacity expansion*

- for time periods of **capacity gluts or over-supply**
  short-run completion marginal unit cost **-** *loss premium → incents capacity retirements*

V. **Possible metrics for measuring Market efficiency is repeated**

Possible Market Design Efficiency measuring metrics;

4. Day-ahead, Real-time, and Congestion rights will achieve a minimum of 95% of the long-run equilibrium cost recovery to induce right investments in productive capacity, with RUC, TCR, and RNU uplifts making up a maximum of 5%.
5. Real-time markets will be reasonably designed for suppliers to recover all market marginal costs required to startup, run, and produce an additional MW of output.
6. Scarcity pricing is reasonably designed to recover most of generators fixed costs unless the market is too long out of equilibrium.

Reference materials:

"Price Formation in Organized Wholesale Electricity Markets", Docket No. AD14-14, FERC Staff Analysis of Shortage Pricing in RTO and ISO Markets. October 2014

"REGULATORY EVOLUTION, MARKET DESIGN AND UNIT COMMITMENT", Richard P. O'Neill, Udi Helman, Paul M. Sotkiewicz of FERC, Michael H. Rothkopf of Rutgers University, William R. Stewart, Jr. of The College of William and Mary

"Electricity Market Design and Efficient Pricing: Applications for New England and Beyond", William W. Hogan, June 24, 2014

"Power System Economics, Designing Markets for Electricity", Steven Stoft, Copyright © 2002 by The Institute of Electrical and Electronics Engineers, Inc. All rights reserved

"Review of PJM's Market Power Mitigation Practices in Comparison to Other Organized Electricity Markets", The Brattle Group, prepared for PJM, September 14, 2007